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Protection Branch Report of Test No. 7-63

# BACTERIAL PENETRATION OF THE MILLIPORE MICROTUBE CARTRIDGE FILTER

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# Bacterial Penetration Of The Millipore Microtube Cartridge Filter

## INTRODUCTION

At the request of Jet Propulsion Laboratory, Pasadena, California, two different pore size (0.73μ and 0.3μ) Microtube filters*, were evaluated for their ability to remove bacterial spores from an air stream. This is part of a series of tests designed to find a high efficiency filter as described in Protection Branch Report of Test 17-62. The filter is to be used to remove microorganisms that might be present in the nitrogen gas employed to flush and replace the ethyelen oxide-freon mixture in an interplanetary space vehicle following sterilization. Six Microtube filters were used in this evaluation. Two of the 0.73μ pore size filters that had been used previously for other tests were supplied by Lockheed Aircraft Corp. The other two 0.73μ pore size filters and the two 0.3μ pore size filters were obtained directly from the manufacturer.

## DESCRIPTION

The Millipore Microtube Cartridge filter is 4-1/2 inches long, 1-5/8 inches in diameter, and has top and bottom caps made of aluminum. The bottom cap is solid but the top cap has a one inch hole in the center. Inside the top cap is a rubber "O" ring. The outside is a pre-filter made of Microfiber glass and is supported by a pre-filter sleeve (this pre-filter appears to be made of stainless steel). Inside the pre-filter sleeve are thirty microetched stainless steel screen tubes covered with Millipore filter material. Sixteen of these tubes make up the outer perimeter of the filter and encircle the remaining fourteen. The thirty tubes are inserted through a stainless steel plate called the header, and sealed with a beeswax type material. The operation of the filter is as follows: air is first drawn through the exterior pre-filter, through the microtubes and exits through the top cap. The maximum temperature these filters can withstand is 250° F (121° C).

## EXPERIMENTAL

Each filter was suspended inside a 1500 liter plexiglass chamber and connected by an air tight rubber tube to the sampling device on the exterior of the chamber. A flow meter was installed in the line to

* Manufactured by Millipore Filter Corp., Bedford, Mass.

measure accurately the flow rate. The filters were tested against Bacillus subtilis var niger spores aerosolized by means of a Vaponefrin nebulizer to give a particle size of 1–5μ in diameter. The approximate concentration of microorganisms was 6 x $10^8$ spores per liter of air.

Samples of the air were taken before and after passage through the filter to determine the concentration of the challenging aerosol and the number of microorganisms penetrating the filter. Cotton collectors were used as the sampling devices. Through the use of critical orifices, the sampling rates were regulated at 10 and 55 liters of air per minute for 30 minutes. This gave a total sample volume of 300 and 1650 liters of air respectively. The cotton from each collector was then placed in an individual water blank, shaken, and aliquots were plated in tryptose agar. All plates were incubated at least 48 hours before counting. Four tests were run on each filter at each flow rate.

## RESULTS AND CONCLUSION

Table I shows the average aerosol concentration before and after filtering, and the per cent penetration at the two flow rates for each of the six filters.

It will be seen from the results that the efficiency of 4 of the 6 filters increased when the air flow was increased from 10 to 55 lpm. On the other hand no significant change in filtration efficiency was observed upon decreasing the pore size from 0.73μ to 0.3μ. The minimum penetration through the Microtube filters was .00007%, the maximum was .002%, excepting filter C (.004%) which had been used for other tests and may have been damaged. This can be compared with a minimum penetration of .000004% and a maximum penetration of .000009% with the Robbins filter. There was no significant difference in the resistance to air flow between 0.73μ pore size Microtube filters and the Robbins filter. There was, however, a 5–10 fold greater resistance to air flow in the 0.3μ pore size Microtube filter.

It is felt that the Robbins type filter using unbonded fiber glass would be the better filter to use for the purpose stated above. The performance of the Robbins filter was more consistent and in all tests several fold more efficient in air filtration than the Microtube filter at its best. Moreover the Robbins mat type filter is less likely to break during handling and use. Back flow which must be avoided in the Microtube filter causes no damage to the Robbins type filter.

Tabl

Per Cent Penetration of B. subtilis var niger spores at Various Air Flows Through Microtube Filters

| Filter No. | Pore Size μ | Air Flow Rate lpm | Aerosol Conc. Org/Liter: Average* Before Filter | Aerosol Conc. Org/Liter: Average* After Filter | Per Cent Penetration |
|---|---|---|---|---|---|
| A | 0.73 | 10 | 1,710,410 | 7.8 | 0.00047 |
| | 0.73 | 55 | 1,764,580 | 5.9 | 0.00034 |
| B | 0.73 | 10 | 1,695,750 | 2.2 | 0.00013 |
| | 0.73 | 55 | 1,981,250 | 4.2 | 0.00025 |
| C | 0.73 | 10 | 2,402,000 | 106.7 | 0.0044 |
| | 0.73 | 55 | 2,716,660 | 12.0 | 0.00044 |
| D | 0.73 | 10 | 2,391,600 | 63.3 | 0.0026 |
| | 0.73 | 55 | 2,402,000 | 1.6 | 0.000065 |
| E | 0.3 | 10 | 2,393,700 | 50.2 | 0.0020 |
| | 0.3 | 55 | 2,456,200 | 4.4 | 0.00018 |
| F | 0.3 | 10 | 2,235,400 | 10.9 | 0.00049 |
| | 0.3 | 55 | 2,310,400 | 1.5 | 0.000066 |

* Each figure represents an average of four tests

Filters C & D were obtained from Lockheed Aircraft Corp.